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G4N NHVSB  
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(56) Documents cited  
GB 2088606 A GB 1552790 A GB 1406314 A  
GB 1395372 A EP 0093832 A1 US 4952908 A  
"Indicator system warns of possible vehicle rollover",  
Eureka Feb. 1990 (vol.10,no.2), page 8.

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## (54) Road vehicle stability indicating system

(57) The system comprises a sensor 10 for producing a signal representative of sideways acceleration and/or angle of tilt of the vehicle, and electronic processing means responsive to said signal for providing an indication of an approaching condition of instability of the vehicle. The sensor 10 is in the form of an accelerometer supported by resilient mountings so as not to be responsive to high frequency vibration. The tractor and trailer of an articulated vehicle may each be provided with an accelerometer. The processing means may include an algorithm 19 for detecting snaking of the vehicle. Road speed and/or angle of steer may also be detected for greater accuracy of indication.

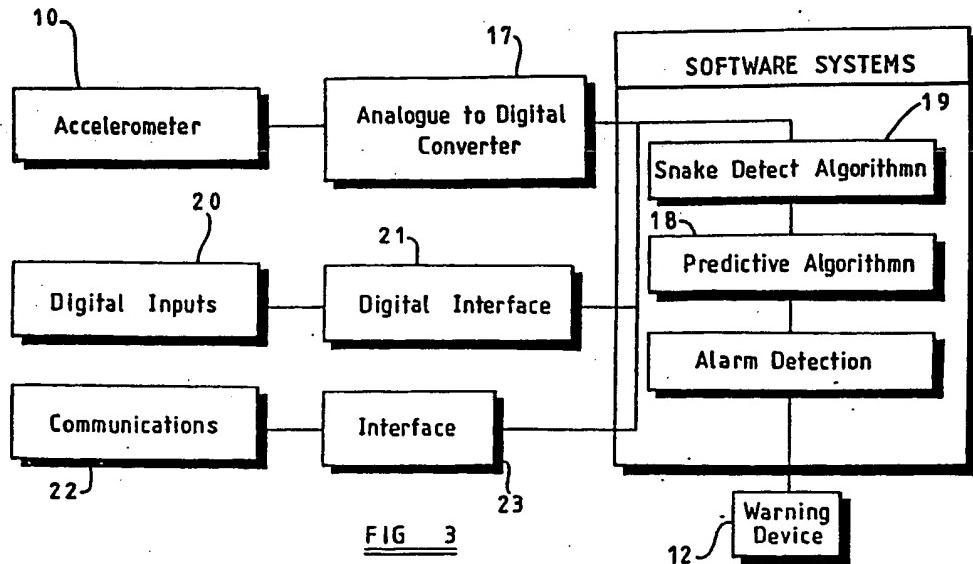


FIG 3

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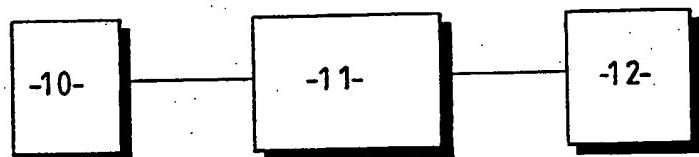


FIG 1

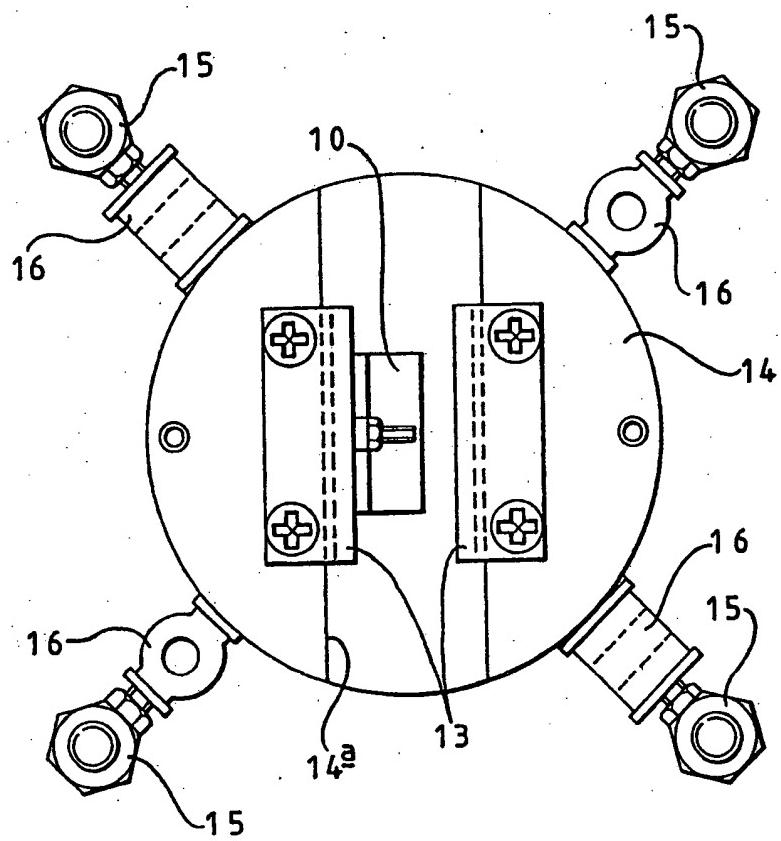
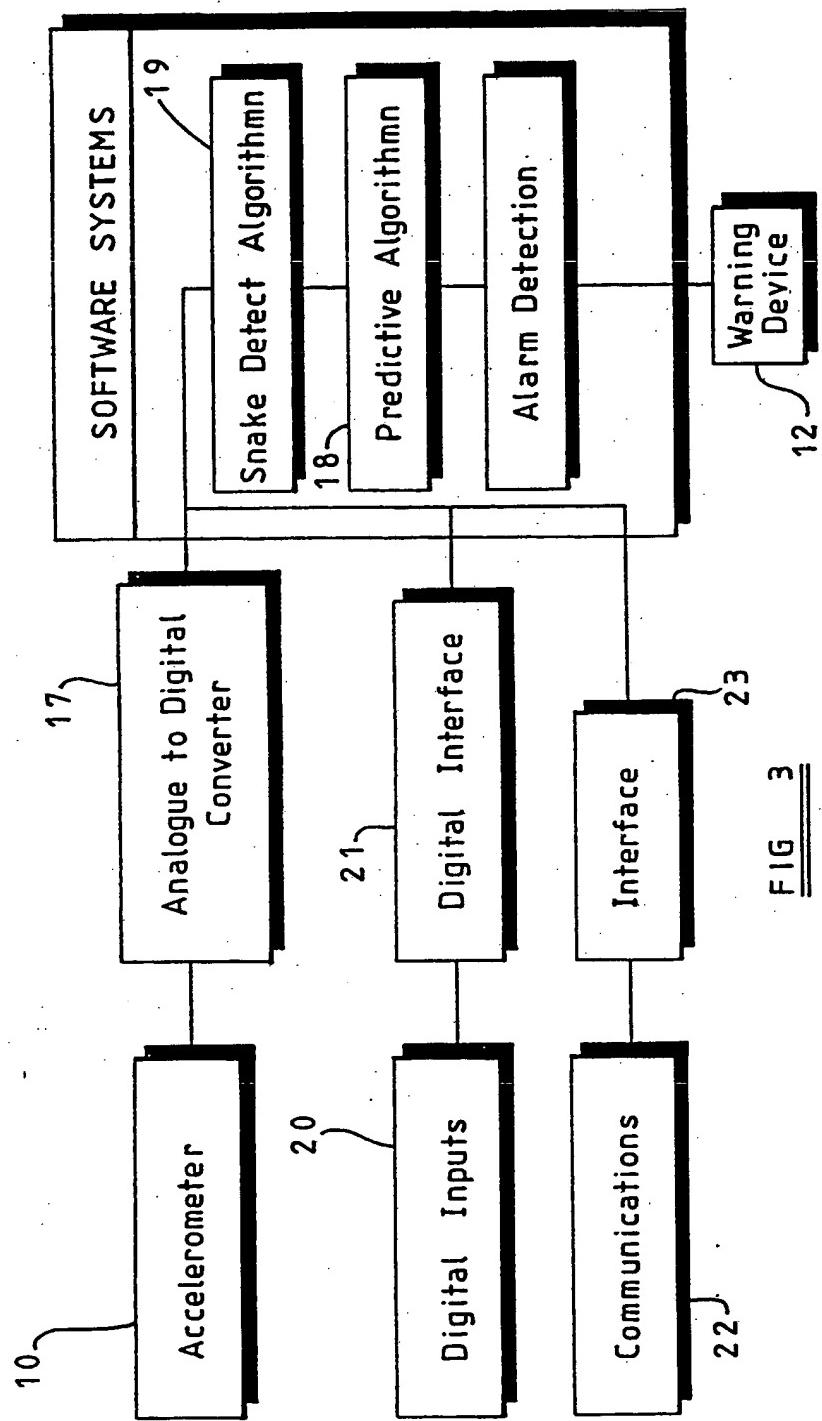


FIG 2



ROAD VEHICLE STABILITY INDICATING SYSTEM

This invention relates to a system for  
5 indicating the stability (or instability) of a road  
vehicle.

A problem exists in the operation of heavy  
road vehicles, and particularly in the case of long  
10 articulated trucks, container transport vehicles and  
fuel tankers in that an individual vehicle can, when  
turning, reach an instability point where only an  
experienced driver is able to take the required  
corrective action. Such an instability point can be  
15 reached when a vehicle is travelling at either high or  
low speed, and, when it occurs, the vehicle may turn  
over or go out of control if the driver does not take,  
or is not capable of taking, immediate action to correct  
the situation.

20

GB 2222560 proposes a system for alerting a  
driver of an approaching condition of instability. This  
system relies on monitoring the road speed and angle of  
steer of the vehicle, but it has been found that this  
25 system is not entirely satisfactory as other factors  
contribute to vehicle instability. These include the  
camber angle of the road, crosswind and the weight and  
distribution of the payload. Surge on tankers is also a

factor and snaking, such as takes place at a roundabout, tends to cause the vehicle to act like a pendulum and have a lower instability threshold.

5       The present invention seeks to provide a stability indicating system which provides a more accurate indication of an approaching condition of instability than is possible with the system proposed previously.

10

According to the present invention, there is provided a stability indicating system for a road vehicle, comprising a sensor for producing a signal representative of sideways acceleration and/or angle of 15 tilt of the vehicle, and electronic processing means responsive to said signal for providing an indication of an approaching condition of instability of the vehicle.

20       Preferably, the sensor produces a signal representative of sideways acceleration and angle of tilt of the vehicle.

25       Preferably, the processing means is able to sense when the vehicle is snaking.

25

The electronic processing means may also be responsive to a signal or signals representative of road speed and/or angle of steer of the vehicle in order to

provide an indication of an approaching condition of instability of the vehicle.

Preferably, the stability indicating system  
5 also includes an audible and/or visual warning device  
operable by the processing means for alerting the driver  
of the vehicle of an approaching condition of  
instability.

10 Advantageously, the warning given by the  
audible and/or visual warning device is progressive.  
For example, an audible warning can become louder or a  
visual flashing warning indicator can increase its rate  
of flashing as the instability point is more closely  
15 approached. The warning should, of course, be  
sufficiently in anticipation of the instability point to  
give an inexperienced driver the opportunity to take  
corrective action.

20 The system is preferably calibrated in  
accordance with vehicle parameters.

Preferably, the sensor is supported by  
resilient mountings so as not to be responsive to high  
25 frequency vibration.

The invention will now be more particularly  
described, by way of example, with reference to the

accompanying drawings, in which:-

Figure 1 is a schematic view of one embodiment  
of stability indicating system according to the present  
invention,

Figure 2 is a plan view showing the sensor of  
Figure 1 and a mounting therefor, and

Figure 3 is a block diagram showing the system  
of Figure 1 in more detail.

Referring to the drawings, the stability  
indicating system shown therein comprises a sensor in  
the form of an accelerometer 10, an electronic  
processing device 11, and an audible and/or visual  
warning device 12.

The accelerometer 10 is supported in a slot  
14a in a metal block 14 by one of a pair of L-shaped  
brackets 13. The block 14 is attached to four  
upstanding, equi-angularly spaced, posts 15 by resilient  
mountings 16. The posts 15 are secured to a road  
vehicle (not shown) with the longitudinal extent of the  
slot 14a parallel to an axis extending fore-and-aft of  
the vehicle. The resilient mountings 16 ensure that the  
accelerometer 10 does not see high frequency vibrations  
generated in the vehicle.

The accelerometer 10 is typically a solid-state, piezoresistive accelerometer such as the accelerometer sold by EuroSensor of 20-24 Kirby Street, London under Model No. 3110. Alternatively, the accelerometer could be a solid state, capacitive accelerometer such as that made by Access Sensors S.A., of Les Charbonnieres, Switzerland under Model No. AMD-CK/0-A-1.

10

The accelerometer 10 responds to lateral movement of the vehicle. The frequency response of the accelerometer extends from d.c. and is limited by a two pole low pass filter at 5Hz. Since the frequency response extends down to d.c., the normal acceleration due to gravity is sensed in addition to sideways acceleration of the vehicle. The accelerometer 10 thus produces a signal representative of sideways acceleration and angle of tilt of the vehicle.

20

The output signal of the accelerometer 10 is converted by an analogue to digital converter 17 and the digital output signal of the converter 17 is sampled regularly. A digital filter algorithm is applied to average out noise and random fluctuations. Within each sampling period the acceleration and rate of acceleration are stored. If the acceleration is greater than a threshold value then the rate of change of

acceleration is combined with the acceleration using a predictive algorithm 18. This value is compared with a predetermined value stored in the processing device 11 and obtained from information relating to vehicle type and characteristics. If the value obtained by the algorithm 18 exceeds this predetermined value, the processing device 11 sends an energising signal to the warning device 12 in order to alert the driver of the vehicle of an approaching condition of instability.

10

The electric processing device 11 also senses when a vehicle is snaking by noting relative sudden changes in sign of the accelerometer output signal and lowers the threshold at which it sends an energising 15 signal to the warning device 12 by reducing the aforesaid predetermined value stored in the processing device 11 when a snake condition is sensed.

Snaking is sensed by a snake detection 20 algorithm 19 which measures the frequency of oscillation and the amplitude of oscillation of the accelerometer output signal. A snake condition is deemed to exist when the frequency of oscillation is within predetermined maximum and minimum limits and is above a 25 minimum amplitude.

A zero crossing detector (not shown) is employed to detect left and right swings of the vehicle.

The time interval between successive zero crossings is measured and the frequency of oscillation can thus be determined.

5 A peak detector (not shown) is employed to measure the peak value of the accelerometer output signal for each left and right swing.

The stability indicating system also has a  
10 number of digital inputs 20 connected to the processing device 11 by a digital interface 21 for calibration and commissioning of the system, and an interface 22 for a communication system 23 which can be used to set up the main parameters for the algorithms 18 and 19 and which  
15 can be used to display stability and snake parameters.

The accelerometer 10 may be secured to the vehicle at any appropriate place and in the case of an articulated vehicle it may be secured to either the  
20 tractor or the trailer of the vehicle provided it is appropriately calibrated. Indeed, an articulated vehicle may have two accelerometers, one secured to the tractor and one secured to the trailer and in this case the electronic processing device 11 would be designed to  
25 monitor the signals from both accelerometers.

Ideally, the electronic processing device 11 and warning device 12 are designed as a single unit and

are located in the driver's cab.

The accelerometer 10 gives a more accurate indication of the stability of the vehicle than is obtained by speed and steer angle sensors, as it more accurately reflects the actual forces experienced by the vehicle and takes account of such factors as prevailing wind conditions and payload distribution. Also, the angle of tilt component of the accelerometer signal takes account of the camber angle of the road.

The energising signal fed by the processing device 11 to the warning device 12 may increase progressively, either in amplitude or repetition rate, as a condition of instability is approached.

It may be found to be beneficial to monitor road speed and/or angle of steer of the vehicle, in addition to sideways acceleration, in order to even more accurately detect a condition of approaching instability and in this case appropriate sensors will be provided.

The electronic processing device can also be arranged to provide a hard copy read-out to enable assessments to be made of driver behaviour.

In some circumstances it may be desirable for

the sensor to produce a signal representative of only sideways acceleration or of only angle of tilt. This may be possible, inter alia, by applying an appropriate filter to the output of the accelerometer.

C L A I M S

1. A stability indicating system for a road vehicle, comprising a sensor for producing a signal representative of sideways acceleration and/or angle of tilt of the vehicle, and electronic processing means responsive to said signal for providing an indication of an approaching condition of instability of the vehicle.
- 10 2. A stability indicating system as claimed in claim 1, wherein the sensor produces a signal representative of sideways acceleration and angle of tilt of the vehicle.
- 15 3. A stability indicating system as claimed in claim 1 or claim 2, wherein the processing means is able to sense when the vehicle is snaking.
- 20 4. A stability indicating system as claimed in any one of the preceding claims, wherein the electronic processing means is also responsive to a signal or signals representative of road speed and/or angle of steer of the vehicle in order to provide an indication 25 of an approaching condition of instability of the vehicle.
5. A stability indicating system as claimed in

any one of the preceding claims, wherein the stability indicating system also includes an audible and/or visual warning device operable by the processing means for alerting the driver of the vehicle of an approaching  
5 condition of instability.

6. A stability indicating system as claimed in claim 5, wherein the processing means is arranged so as to progressively increase the energising signal which it  
10 sends to the warning device as a condition of instability approaches.

7. A stability indicating system as claimed in any one of the preceding claims, wherein the system is  
15 calibrated in accordance with parameters of the vehicle - for which it is intended.

8. A stability indicating system as claimed in any one of the preceding claims, wherein the sensor is  
20 supported by resilient mountings.

9. A stability indicating system as claimed in any one of the preceding claims, wherein the sensor is in the form of an accelerometer.

25

10. A stability indicating system as claimed in claim 9, wherein the accelerometer is a solid state, piezoresistive or capacitive accelerometer.

11. A stability indicating system substantially as hereinbefore described with reference to the accompanying drawings.

5

12. A vehicle equipped with a stability indicating system as claimed in any one of the preceding claims.

Patents Act 1977

Examiner's report to the Comptroller under  
Section 17 (The Search Report)

Application number

9213907.0

Relevant Technical fields

(i) UK CI (Edition K ) B7H (HXG, HXJ); G4N (NHVS)

(ii) Int CI (Edition 5 ) B60R 16/02; B60Q 5/00, 9/00

Search Examiner

J L TWIN

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

COMPLETED  
13 AUGUST 1992

Documents considered relevant following a search in respect of claims

1, 5, 6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2088606 A (MIRA)	1, 5, 6
X	GB 1552790 (ALERTO-O-DRIVE)	1, 5
X	GB 1406314 (COUPE)	1, 5
X	GB 1395372 (MIZE)	1, 5
X	EP 0093832 A1 (VESYRIS)	1, 5
X	US 4952908 (SANNER)	1, 5
X	"Indicator System Warns of possible vehicle rollover"; Eureka, Feb 1990, (Vol 10 No. 2) page 9	1, 5, 6

Category	Identity of document and relevant passages	Relevance to claim(s)

#### Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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